Sustainable Office Water Strategies: Quantitative Analysis of Bottled, Filtered, and Tap Water Systems

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Abstract. Water consumption in office environments represents a significant yet often overlooked aspect of corporate sustainability. This study aims to evaluate office drinking water preferences within the framework of environmental, economic, and social sustainability. The research was conducted at the headquarters of a telecommunications company in Istanbul, where the existing water supply system relies on 16 dispensers and an average monthly consumption of 394 bottled gallons. A comprehensive assessment was performed to compare the environmental and economic impacts of bottled water consumption, particularly its carbon footprint, water footprint, and waste generation, with the potential benefits of filtered tap water systems. Two different brands of filtration devices, referred to as Brand X and Brand Y, were examined to evaluate their technical performance and sustainability implications. Parameters such as energy consumption, water purification capacity, and wastewater ratios were analyzed and compared against the bottled water system. The analysis revealed that bottled water production, packaging, and distribution processes create substantial environmental costs. Specifically, bottled water use resulted in an estimated 1,063.8 kg of CO_2 emissions per month, while the production and disposal of plastic containers contributed significantly to waste generation and marine pollution risks. In contrast, filtered tap water systems demonstrated markedly lower environmental impacts. Brand X consumed 8,240 kWh of electricity per month, corresponding to 6,923 kg of CO_2 emissions, whereas Brand Y, with a more energy-efficient system, produced only 4,969 kg of CO_2 per month.

Keywords: Sustainability, Office Water, Filtration Units

1 Introduction

Water, in addition to being an indispensable resource for the sustainability of life, has become one of the fundamental components of contemporary environmental and corporate sustainability strategies. Increasing urbanization, industrialization, and climate change are exerting growing pressure on water resources, making the efficient use and

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management of water a global priority [1,2]. Water consumption in corporate structures, particularly in the context of drinking water supply, though less visible than energy and carbon management, constitutes a significant factor contributing to overall environmental sustainability performance [3,4].

Although bottled water systems are among the most common drinking water supply methods in office environments, they create significant environmental burdens due to high energy consumption, carbon emissions, and plastic waste generation throughout production, packaging, and distribution processes [5-7]. According to a recent life cycle assessment (LCA)–based study, the production, packaging, and distribution of 500 mL bottled water result in greenhouse gas emissions of approximately 8.28 E–02 kg CO_2-eq./unit [5]. In addition, the long persistence of plastic waste in the environment increases the risk of microplastic pollution in marine ecosystems [8].

In contrast, filtered tap water systems are considered a more advantageous alternative in terms of both environmental and economic sustainability. Recent life cycle assessment (LCA)–based studies have shown that filtered tap water systems produce significantly lower carbon footprints and energy consumption compared to bottled water [9]. Moreover, these systems provide substantial savings in maintenance and operational costs over the long term.

However, the formation of user preferences is influenced not only by environmental and economic factors but also by perceived hygiene, taste, trust, and social norms. A comprehensive study conducted by de França Doria (2010) revealed that public perception of drinking water quality is shaped by multidimensional factors such as organoleptic properties (particularly taste), risk perception, trust level, and past experiences. In this context, consumers generally perceive bottled water as more reliable and of higher quality, whereas individuals with greater environmental awareness tend to prefer filtered or tap water [10]. Additionally, Saylor et al. (2011) found that the lack of trust in tap water and perceived health risks are key determinants of bottled water preference even in regions with advanced infrastructure, while factors such as taste and convenience further reinforce this tendency [11].

In this context, the development of sustainable drinking water strategies in office environments not only reduces environmental impacts but also contributes to strengthening corporate social responsibility (CSR) policies. Therefore, this study aims to comparatively evaluate the environmental, economic, and social sustainability dimensions of bottled water, filtered tap water, and direct tap water systems through a corporate case study in Istanbul. The findings highlight the strategic importance of transitioning to sustainable water consumption models in offices in terms of both environmental performance and operational efficiency.

2 Material and Methods

2.1 Research Area

This study aims to conduct a comparative analysis of drinking water supply alternatives in office environments specifically bottled water and household-type filtration systems in terms of environmental and economic sustainability. The research was

carried out at the headquarters of a telecommunications company operating in Istanbul. In the current situation, drinking water needs are met through 19-liter bottled water dispensers installed on 16 floors of the building. During January 2024, a total of 394 bottles were consumed, corresponding to approximately 7,486 liters of monthly water use. Table 1 presents the number of employees and the building occupancy rate.

Table 1. Number of Employees and Daily Entry Data in the Facility (January 2024).

Category	Number of People	Description
Company employees	13,169	Permanent staff
Subcontracted employees	5,359	Outsourced personnel
Total number of employees	18,528	–
Average daily building entry	843 persons/day	Based on 22 working days

The headquarters building consists of 16 floors, with one water dispenser located on each floor. The usage percentages of the dispensers by floor are presented in Table 2.

Table 2. Floor-Based Distribution of Water Dispenser Usage in the Facility (%).

B4	B3	B2	B1	Z	A	1	2	3	4	5	6	7	8	9	10
5 %	5 %	8 %	15 %	10 %	3 %	8 %	5 %	8 %	5 %	5 %	5 %	5 %	5 %	5 %	3 %

2.2 Data Collection and Analysis

During the data collection process, water consumption records, employee numbers, and filtration system quotations were evaluated. Water consumption was calculated based on bottled water usage data, while the carbon footprint analysis was conducted using values that vary depending on the source of tap water. Accordingly, emission factors of <1 g CO_2/L for surface water sources, 0.12 g CO_2/L for recycled systems, 0.22 g CO_2/L for groundwater, 0.35 g CO_2/L for brackish water, and 1.52 g CO_2/L for desalinated seawater were considered [12]. Additionally, the carbon footprint of tap water has been reported to vary regionally, averaging approximately 0.221 g CO_2/L [13].

In the study, two different brands of dispenser-type water filtration systems were evaluated as alternatives to the existing bottled water system. The technical and economic characteristics of these devices are presented in Table 3.

Table 3. Technical Specifications of Two Different Dispenser-Type Water Filtration Devices.

Specification	Brand X Dispenser-Type Water Filtration Device	Brand Y Dispenser-Type Water Filtration Device
Daily Filtration Capacity	185 liters	240 liters
Storage Tank Capacity	15 liters	21 liters
Wastewater Ratio	40%	66.5%

Specification	Brand X Dispenser-Type Water Filtration Device	Brand Y Dispenser-Type Water Filtration Device
Functions	Hot, Cold, and Room Temperature Water	Hot, Cold, and Room Temperature Water
Filter Type (Sediment, Pre- and Post-Carbon, Reverse Osmosis) Replacement Interval	6 months	6 months
Price	$16/month (2 years) = $384	$23/month (2 years) = $552

3 Results and Discussion

3.1 Environmental Aspect

Carbon Footprint of Water Dispensers and Bottled Water Use

The carbon footprint of bottled water refers to the greenhouse gas emissions generated throughout the stages from production to final consumption, and this value varies depending on numerous factors. To reduce the carbon footprint of bottled water, environmental impacts must be considered across all processes from production to delivery. Reuse, recycling, and environmentally friendly transportation methods play a critical role in minimizing these emissions. One 19-liter bottle is responsible for approximately 2.7 kg of CO_2 emissions [14].

At the facility where this study was conducted, 394 bottles of 19 liters are consumed monthly. Based on the estimate that one 19-liter bottle causes approximately 2.7 kg of CO_2 emissions, the calculated monthly emission values are presented in Table 5. In addition, the water dispensers used for bottled water contain cooling and heating systems that consume energy to keep the water hot or cold. This feature is directly related to electricity consumption and CO_2 emissions. The 16 water dispensers at the headquarters operate 24 hours a day for 22 days per month. According to the electricity measurements taken in November 2023 from the dispensers on floors B1 and Ground, two dispensers consumed 156.88 kWh over 13 days. Monthly CO_2 emissions from electricity consumption can be calculated in metric tons using the formula (monthly electricity use (kWh) × 0.84 / 1000). When the electricity consumed by two dispensers in 13 days is proportioned to 16 dispensers used 24 hours per day for 22 days, each dispenser is estimated to consume 132.66 kWh per month (Table 4).

Table 4. Monthly Electricity Consumption from Dispenser Use.

Device	Unit	Quantity	Unit Monthly Electricity Consumption (kWh)	Total Monthly Electricity Consumption (kWh)
Water Dispenser	Unit	16	132.66	2122.56

Based on these data, the CO_2 emissions and carbon footprint arising from electricity consumption are presented in Table 5.

Table 5. Carbon Footprint of Water Dispenser and Bottled Water Use.

Product	Unit	Quantity	Unit CO_2 Emissions (kg/month)	Total CO_2 Emission (kg/month)
Water Dispenser	Unit	16	111.25	1780
Bottled Water (19 L)	Unit	394	2.7	1063.8
Total CO_2 Emission	-	-	-	2843.8

Accordingly, 16 dispensers operating 24 hours for 22 days per month at the headquarters are responsible for 1780 kg of CO_2 emissions. Monthly consumption of 394 bottled gallons results in 1063.8 kg of CO_2 emissions. Therefore, the combined monthly CO_2 emissions from dispenser and bottled water use were determined to be 2843.8 kg (Table 5).

Carbon Footprint of Using Brand X and Brand Y Filtration Devices

The carbon footprint of Brand X and Brand Y dispenser-type filtration devices was calculated based on their electricity consumption and the carbon emissions associated with municipal tap water use. The electricity and water consumption characteristics of Brand X and Brand Y devices are provided in Table 6.

Table 6. Electricity and Water Consumption Characteristics of Brand X and Brand Y Filtration Devices.

Brand	Quantity	Cooling (W)	Heating (W)	Wastewater Ratio (%)	Monthly Electricity Use (kWh)	Monthly Water Use (L)
X	16	874	100	40	8240	10480
Y	16	600	100	66.5	5914	12464

Values related to the carbon footprint of using Brand X and Brand Y filtration devices are shown in Table 7.

Table 7. Carbon Footprint of Brand X and Brand Y Filtration Devices

Factor	Brand X Amount	Brand X CO2 (kg/month)	Brand Y Amount	Brand Y CO2 (kg/month)
Tap Water (L)	10480	1.44	12464	1.7
Electricity Consumption (kWh)	8240	6922	5914	4968

Factor	Brand X Amount	Brand X CO2 (kg/month)	Brand Y Amount	Brand Y CO2 (kg/month)
Total CO_2 Emission	-	6923.44	-	4969.7

If 16 units of Brand X and Brand Y filtration devices operate continuously for 24 hours over 22 days at the headquarters, they produce total CO_2 emissions of 6923.44 kg and 4969.7 kg per month, respectively (Table 7). It was determined that the primary source of carbon emissions associated with filtration devices is electricity consumption.

Carbon Footprint of Tap Water Use

The CO_2 emission factor for municipal tap water use is 0.137 g per liter. If drinking water needs at the headquarters were met entirely through tap water, approximately 1 kg of CO_2 would be generated for 7486 liters of water. This value is substantially lower than the emissions associated with bottled water and filtration device alternatives.

Water Footprint of Water Dispenser and Bottled Water Use

The water footprint of water dispenser and bottled water use is determined by the energy, water, and other resources consumed throughout the stages from water extraction to final consumption. This process includes abstraction from the source, treatment, bottling, transportation, and cooling. The amount of water and energy used at each stage affects the total water footprint, which requires careful evaluation in terms of environmental sustainability.

A previous study determined that 3.43–6.92 liters of water are consumed for each 1.5 L PET bottle, and approximately 30–90 liters of water are used for a 19-liter bottle [15]. In this study, approximately 30 liters of water were assumed per bottle (Table 8).

Table 8. Water Footprint of Bottled Water Use

Product	Unit	Quantity	Unit Water Footprint (L)	Total Water Footprint (L)
Bottled Water (19 L)	Unit	394	30	11820

Water Footprint of Using Brand X and Brand Y Filtration Devices and Tap Water

The wastewater ratio of the Brand X dispenser-type filtration device is 40%. Therefore, to meet the headquarters' monthly drinking water demand of 7486 liters currently supplied via bottled water, the Brand X device would require 10,480 liters of water. The wastewater ratio of the Brand Y filtration device is 66.5%. Thus, Brand Y would require 12,464 liters of water to meet the same drinking water demand. In contrast, for

tap water use, the amount of water needed equals the amount consumed. This ensures that only the required amount is used, allowing for efficient water resource management. If the headquarters' drinking water demand were met through tap water, the facility would consume only 7486 liters—the same as the monthly drinking amount (Figure 1).

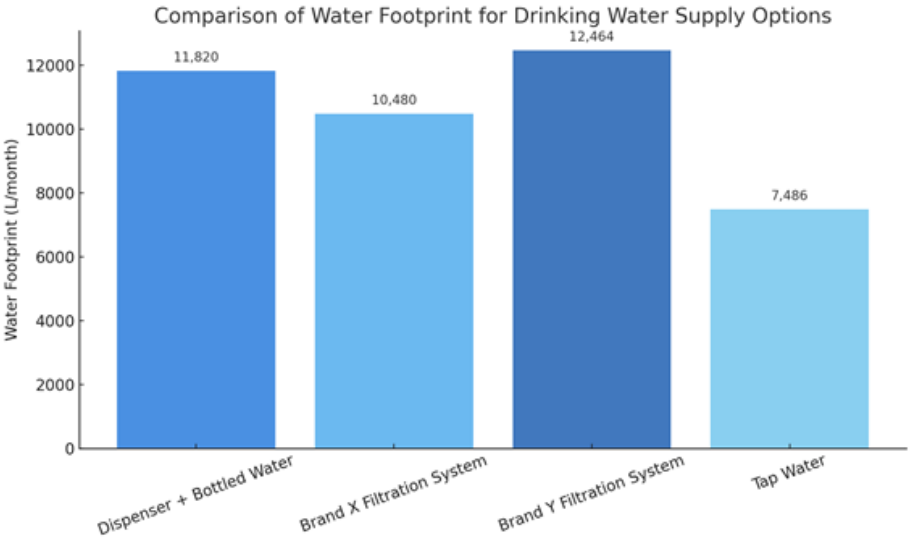

Fig. 1. Water Footprint Comparison of Drinking Water Usage Alternatives

A comparison of the water footprints of different drinking water alternatives shows that the dispenser and bottled water system has the highest environmental impact with a footprint of 11,820 liters per month. This high value results mainly from the indirect water consumption associated with bottle production, cleaning, and distribution. Although the Brand X filtration device has a lower footprint of 10,480 liters/month, wastewater generation in the filtration process still leads to a significant total. Brand Y, requiring 12,464 liters/month, has the highest water footprint among the alternatives. Tap water, on the other hand, has the lowest footprint at 7,486 liters/month because it does not require additional treatment or packaging steps.

3.2 Economic Analysis

Economic Analysis of Water Dispenser and Bottled Water Use

The current situation at the headquarters includes the electricity cost of running the water dispensers and the purchasing cost of the bottled water. Monthly bottled water consumption is 394 units, each costing $2.5. Therefore, $985 is spent monthly on bottled water. The electricity cost of operating the dispensers was calculated using unit electricity prices based on the November 2023 measurements on floors B1 and

Ground, where two dispensers consumed electricity costing $1.27 over 13 days. Using this data, the monthly electricity cost of operating 16 dispensers 24 hours per day for 22 days was found to be $17.28 (Table 9). Thus, the combined monthly cost of bottled water and dispenser use is $1002.28.

Table 9. Monthly Cost of Dispenser and Bottled Water Use

Product	Unit	Quantity	Monthly Cost
Water Dispenser	Unit	16	$17.28
Bottled Water	Unit	394	$985.00
Total Monthly Cost	–	–	$1002.28

Economic Analysis of Using Brand X and Brand Y Filtration Devices and Tap Water

The unit price of the Brand X filtration device is $384. The plan involves installing one filtration device for each dispenser. Therefore, 16 Brand X units would cost a total of $6,144. The annual filter replacement and maintenance cost per device is $136.65. Based on these values, the total monthly cost of purchasing and maintaining 16 Brand X devices is $246 (Table 10).

To meet the headquarters' drinking water demand of 7486 liters per month, the Brand X filtration system requires 10,480 liters of water. When 16 Brand X devices operate 24 hours for 22 days, their electricity consumption totals 8240 kWh. Monthly costs include $64 for device acquisition, $182 for filters and maintenance, and $125 for electricity and water, resulting in a total monthly cost of $371 (Table 10).

The unit price of the Brand Y filtration device is $552. Installing 16 units results in a total investment of $8832. Monthly purchase and maintenance cost for Brand Y is $292. Brand Y requires 12,464 liters of water to meet the 7486-liter monthly drinking water demand. Its electricity consumption over 22 days of 24-hour operation totals 5914 kWh. Monthly costs include $92 for device purchase, $200 for filters and maintenance, and $101.75 for electricity and water, totaling $393.75 (Table 10).

Table 10. Monthly Cost of Brand X and Brand Y Filtration Devices

Product	Monthly Purchase Cost	Monthly Filter Replacement Cost	Monthly Electricity Cost	Monthly Water Cost	Total Monthly Cost
Brand X Filtration Device	$64.00	$182.00	$100.00	$25.00	$371
Brand Y Filtration Device	$92.00	$200.00	$72.00	$29.75	$393.75

The cost of tap water consists only of the volume-based water tariff, with no electricity or maintenance costs. Since the headquarters consumes 7486 liters of drinking water monthly, and the price of 1 m^3 (1000 L) is $2.4, the monthly cost would be $18 if drinking water needs were met directly with tap water.

4 Conclusion

This study provided a comprehensive evaluation of the environmental, economic, and social sustainability dimensions of drinking water supply systems used in office environments. The findings revealed that bottled water systems have adverse environmental impacts due to high carbon emissions, energy consumption, and plastic waste generation during production, packaging, and distribution processes. In contrast, filtered tap water systems emerged as a much more sustainable alternative in terms of both energy efficiency and waste reduction.

Economic evaluations revealed that filtration systems significantly reduce operational costs in the long term and enhance resource efficiency at the corporate level. From a social perspective, it was observed that employees' drinking water preferences are primarily influenced by perceptions of hygiene and trust; however, individuals with higher environmental awareness tend to prefer filtered or tap water. This finding indicates that user perception, alongside technical infrastructure, plays a critical role in promoting sustainable consumption behaviors.

Overall, it was concluded that transitioning to filtered tap water systems in office environments represents the most suitable solution for reducing environmental impacts, lowering costs, and strengthening corporate sustainability policies. Accordingly, it is recommended that institutions invest in energy-efficient filtration technologies, gradually reduce plastic consumption, and develop communication strategies to enhance employee awareness.

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Disclosure of Interests.

The authors declare no conflict of interest.

Ethics committee approval

The paper is original unpublished work, and it is not under consideration for publication anywhere else. No data, text, or theories by others are presented, all relevant literature is cited.

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